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PERCEIVED INDOOR AIR QUALITY AND PSYCHOSOCIAL WORK ENVIRONMENT IN OFFICE, SCHOOL AND HEALTH CARE ENVIRONMENTS IN FINLAND

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Abstract

Objectives: The study examined the extent and prevalence of perceived indoor environment-related (IE-related) symptoms environmental complaints and psychosocial work environmental factors in Finnish office, school and health care environments. **Material and Methods:** The data were collected from non-industrial workplaces (N = 455) in 2011–2012 and 2015–2017 using the Finnish Institute of Occupational Health's *Indoor Air Questionnaire (IA Questionnaire)*. Suspicion of IE-related problems was reported in 59% of workplaces. The data consisted of 28 826 employees' responses. **Results:** The employees reported symptoms and environmental discomfort in office environments less often than in school or health care environments. The most often reported IE-related complaints were stuffy air (39% of respondents), dry air (34%) and insufficient ventilation (33%). The most often reported symptoms were irritation of the nose (27% of respondents), irritation of the eyes (26%), and hoarse or dry throat (24%). The results showed differences between the perceived IE in office, school and health care environments. **Conclusions:** Compared to earlier findings, the most often perceived IE-related symptoms and complaints have increased in Finnish health care environments. The office employees' perceptions of psychosocial work environment remained fairly unchanged whereas health care personnel more often assessed their psychosocial environment as positive compared to previous reports. Instead of exact reference values, comparing the results of *IA Questionnaires* with the distributions and mean values of the results of this study may be more informative for those striving to solve IE-related problems. The presented distribution and mean values of perceived symptoms, environmental complaints and psychosocial work environment might help to relate the results to other workplaces. This, in turn, might increase the understanding that *IA Questionnaire* results are influenced by many factors. The results presented can be used as new reference material when interpreting the results of *IA Questionnaires* in office, school and health care environments. Int J Occup Med Environ Health. 2020;33(4):479–95

Key words:

Indoor Air Questionnaire, school, health care, perceived indoor environment, reference material, office

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INTRODUCTION

Perceived indoor environment –

a complex mix of different factors

In Finland there has been extensive, long-term concern about indoor air quality (IAQ) and its impact on health, specifically in non-industrial workplaces. However, although IAQ problems are common in Finland, their prevalence or detected IAQ is not exceptional in comparison to other countries [1–5]. It is also known that indoor environment (IE) comfort influences satisfaction factors in different ways, depending on the country [6], location [4] and socio-cultural context [4].

According to Statistics Finland's Quality of Work Life Survey 2013 [7], more than 1 in 4 Finnish wage and salary earners are very satisfied with their workspaces. However, female wage and salary earners reported more noise and disruptions in their work environment than males [7]. The most often reported environmental factors were noise, too low or too high temperatures, insufficient ventilation, and dust [7]. According to the same study, the prevalence of different types of experiences is not, in all cases, directly related to the reported environmental factors. Thus, perceived and measured IAQ may be different [8–10].

Several studies have found that perceived IAQ varies according to building types [1,4]. Different building-related factors [4,11–13], individual factors [12,14], the psychosocial environment [10,15–17], the questionnaire information itself [18], and worries [19] have been found to affect perceived IAQ. A previous study found that indoor environmental satisfaction is a flexible, subjective experience, as are cultural factors [6]. Based on earlier studies [8–10,15,16], problem-solving should take account of related contextual factors, such as the condition of the building, perceived IAQ, psychosocial work environment, individual factors, and problem-solving measures. One problem-solving method is to use the *Indoor Air Questionnaire (IA Questionnaire)* to ask employees about their experiences of IE and the psychosocial work envi-

ronment. *Indoor Air Questionnaires* are a relevant part of the IE problem-solving process and are a well-established and commonly used tool for monitoring perceived IE and psychosocial work environment in Finnish workplaces. *Indoor Air Questionnaires* are primarily intended for health care professionals, but multi-professional teams can also widely use their results as part of problem-solving.

Office environments

In the 1980s, WHO reported that up to 30% of employees complained of building-related symptoms [20]. In the 1990s, Andersson [18] reported reference values based on the results of *Örebro MM-40 Indoor Climate Questionnaire (Örebro MM-40)* surveys in 9 non-industrial buildings. The most prevalent IE-related complaints were dry air (20% of respondents), stuffy air (10%) and dust or dirt (10%), and the most prevalent symptoms were fatigue (10% of respondents), irritated/runny nose (9%) and irritation of the eyes and itching scalp or ears (6%) [18]. In 2004, Reijula et al. [21] reported the *Örebro MM-40* results of 11 154 respondents in 122 non-industrial workplaces. The most prevalent IE-related complaints were dry air (35% of respondents), stuffy air (34%), draft (22%), too high room temperature (17%) and unpleasant odors (17%) [21]. The most prevalent IE-related weekly symptoms were irritated/runny nose (20% of respondents), irritation of the eyes (17%), fatigue (16%), irritation of the skin on the hands (15%) and hoarse throat (14%) [21].

A study published in 2015 [12] on indoor climate comfort in Italian offices revealed that >31% of employees reported symptoms and 65% had made IE-related complaints. In the 2000s, office workplace studies reported (using *Örebro MM-40*) general IE-related complaints of varying temperatures (21% of respondents) [12], dry air (9%) [12] and stuffy air (8%) [12], while IE-related weekly symptoms were upper respiratory symptoms (30% of respondents) [22], lower respiratory symptoms (25%) [22] and eye irritation (48%) [22].

School environments

In schools, teachers reported more IE-related symptoms than pupils [18,23]. There is some evidence of teachers' increasing respiratory symptoms in classrooms with too high or too low IA relative humidity [24], poor building condition, and damp and mould exposures [25]. In previous studies in the USA, 72–84% of teachers reported nasal symptoms [25,26], 43% asthma-like symptoms [25], 18–40% throat irritation [25,26], 4–33% wheezing [25,26] and 30% lower respiratory symptoms [25]. In a Finnish follow-up study [27], the symptom prevalence (using *Örebro MM-40*) among the teachers was high before remediation of the buildings. Teachers' most often reported IE-related symptoms were hoarseness (93% of respondents), rhinitis (74%), dyspnea (37%) coughing (30%) and fatigue (27%) before remediation of the buildings.

Health care environments

Employees in hospitals more often reported IE-related symptoms and complaints (using the *Örebro MM-40*-based questionnaire) than employees in offices in Finland [1]. Furthermore, employees more often reported IE-related symptoms and complaints in hospital buildings in need of repairs than in hospital buildings not requiring repairs [1]. According to the same study, the most common IE-related weekly complaints in hospitals were dry air (46% of respondents), stuffy air (40%), noise (30%) and draft (27%). The most common IE-related weekly symptoms were irritation of the nose (25% of respondents), irritation of the hands (24%), irritation of the eyes (23%) and fatigue (21%) [1].

A recent study of Finnish hospital environments [2] found that the most prevalent IE-related symptoms (using *Örebro MM-40*) were irritated/runny nose (52% of respondents), irritation of the eyes (46%), irritation of the skin on the face (44%) and fatigue and irritation of the skin on the hands (43%). However, in this study [2], building investigation results did not explain

the perceived IAQ-related symptoms. In the authors' earlier study [9], the results (using the *Örebro MM-40*-based questionnaire) were very similar, such as the prevalence of symptoms of irritation of the nose (>40% of respondents), irritation of the eyes (>30%) and irritation of the skin on the hands (>30%) in Finnish hospital environments. The authors also deduced that extensive impurity sources in the premises are not always associated with the prevalence of perceived symptoms [9].

Psychosocial work environment

In former studies, psychosocial work environment has shown to be significantly associated with IAQ problems, IE-related symptoms and complaints [8,15,17], and thus it was also briefly surveyed in *Örebro MM-40*. In this respect, this questionnaire could be useful as a rough practical screening method for analyzing the role of psychosocial environment. Lahtinen et al. [15] stated in their study that 75% of respondents perceived their work as being often interesting, 72% received help from their colleagues, 20% had too much work, and 35% were able to influence their working conditions in Finnish office environments. The earlier study of Finnish hospital environments [1] by the Finnish Institute of Occupational Health (FIOH) found that 82% of respondents perceived their work as being often interesting and stimulating, 78% often received help from their colleagues, 21% were often able to influence their working conditions, and 22% often had too much work to do.

The aim of the study

The aim of this study was to assess the prevalence of symptoms and environmental complaints related to IE and perceived psychosocial work environment in office, school and health care environments in Finland in the 2010s. Since *IA Questionnaires* (*Örebro MM-40*-based) are an established and commonly used tool in the IE problem-solving process in Finnish workplaces, the authors' aim

was also to collect up-to-date reference material that can be used to interpret the results of the *IA Questionnaires* (Örebro MM-40-based) in office, school and health care environments.

MATERIAL AND METHODS

Materials

Since 1995, FIOH has used a standardized *IA Questionnaire* as a parallel tool with other methods to investigate IE-related problems in workplaces. Usually, someone from the workplace's occupational health care service contacts FIOH to investigate the extent, severity and probability of the IE-related problem at the workplace. Monitoring the state of perceived IE via a questionnaire is also a normal follow-up measure, for example, after IA-related repairs. In this study, the data were collected primarily from different workplaces a part of FIOH's customer services, and secondly through FIOH's research and development projects. The respondents were from different non-industrial workplaces and different locations in Finland. The questionnaire was answered via the internet. The FIOH's *IA Questionnaire* link was emailed to the participants. The email also contained a cover letter to explain the questionnaire's purpose and method, and information about the use of the results and personal data protection. Participation was voluntary. To ensure reliable results, the response rate had to be high. Therefore, both FIOH and the employer reminded the participants to answer to the questionnaire.

The data included 28 826 *IA Questionnaire* responses from 2011–2012 and 2015–2017. This study used all the queries made by FIOH during these years. The background information revealed that workplaces either had suspected IE-related problems ($N = 16902$ [58.6%]) or that the questionnaire was used for monitoring the state of perceived IE ($N = 4244$ [14.7%]). The data did not include information on the purpose of the questionnaire in the workplaces ($N = 7680$ [26.6%]). In this study, the authors fo-

cused on the overall data covering 28 862 employees' responses. They also analyzed separately the responses from the workplaces monitoring the state of perceived IE ($N = 4224$). The mean response rate was 77%, with a range of 43–100%. As regards gender and age, 70% of respondents were women and mean age was 47.

The data included questionnaire responses from several work environments, 206 offices (57% of responses), 122 schools (18%) and 127 health care environments (25%). The office workplaces were from the government sector (39%), the public sector (21%), the private sector (34%) and other sectors (6%). The schools were from the government sector (4%), the public sector (93%) and other sectors (3%). The school workplaces included universities, elementary and high schools, and schools of applied sciences. The health care workplaces were from the government sector (2%), the public sector (75%), the private sector (19%) and other sectors (4%).

Questionnaire

The *IA Questionnaire* is based on Örebro MM-40 [18], modified slightly by FIOH in 2006–2008 [1]. It is divided into 4 parts and contains questions on:

- 1) the work environment,
- 2) work arrangements,
- 3) individual allergy history,
- 4) work environment-related symptoms.

In the first part, the work environment questions deal with draft, stuffy and dry air, insufficient ventilation, mould or other unpleasant odors, room temperatures, tobacco smoke, noise, dim light or reflections, and dust or dirt.

In the second part, individual allergy history concerns past or present asthma, allergic rhinitis and atopic eczema.

In the third part, the IE-related symptoms questions deal with fatigue, headache, feeling heavy-headed, concentration difficulties, fever or chills, irritation of the eyes, irritation of the nose, hoarse or dry throat, coughing, coughing at night, shortness of breath, wheezing, irritation of

the skin on the face, irritation of the skin on the hands, muscular pain and joint pain.

In the first 3 parts, the questions have 3 response options: “yes, often,” “yes, sometimes” and “no, never.” The authors’ study focused on the IE-related symptoms and environmental complaints that occurred weekly and the answer alternative “yes, often.”

In the fourth part, the psychosocial work environment is evaluated using the following questions: “Do you regard your work as interesting and stimulating?” “Do you have too much work?” “Are you able to influence your working conditions?” “Do your fellow workers help you with work-related problems?” The response options are: “yes, often,” “yes, sometimes,” “no, seldom or rarely,” “no, never.”

To study perceived stress, a validated single-item measure of stress symptoms is used [28], “Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?” The response options were: “not at all,” “just a little,” “some,” “quite a lot,” “very much.” In the analyses, the authors combined the levels “not at all” and “some” and “just a little” into 1 level, and the levels “quite a lot,” and “very much,” into a single level.

Statistical analyses

For the statistical analyses, the authors used the SPSS 25.0 program. In the analyses, they calculated the confidence intervals for percentages based on normal distribution. The calculations also covered the distribution of responses separately for office, school and health care environments. Distribution values were calculated at the workplace level.

As this was a questionnaire-based study in which participation was voluntary and involved no intervention on individuals, according to the Finnish legislation it did not require handling by an ethics committee.

RESULTS

Indoor environment-related complaints

The IE-related complaints differed in office, school and health care environments (Table 1). The health care employees more often reported complaints related to stuffy air (55.7% of respondents), dry air (49.9%), insufficient ventilation (47.7%), mould odor (26.6%) and unpleasant odor (30.5%) than the school or office employees (Table 1). The school employees more often reported complaints about noise (32.8% of respondents) and dust or dirt (20.2%) than the other groups. The office employees less often reported complaints about stuffy air (30.0% of respondents), dry air (27.7%), insufficient ventilation (25.0%), draft (16.7%) and dust or dirt (16.6%) than the other groups (Table 1).

Table 2 presents data on the distribution of perceived IE-related weekly environmental complaints. The mean values in Table 1 are mostly within the range of 50th–75th percentile (Table 2).

Table 3 illustrates the percent mean values of employees’ IE-related complaints in workplaces that were monitoring the state of perceived IE, for example, after IA-related repairs. In addition, IE-related complaints were common in these workplaces.

Indoor environment-related symptoms

The perceived IE-related symptoms differed in the office, school and health care environments (Table 1). The health care employees more often perceived, for example, symptoms of irritation of the nose (39.2% of respondents), irritation of the eyes (37.8%), hoarse or dry throat (33.8%), fatigue (25.9%), or feeling heavy-headed (26.0%) than the other groups (Table 1). The school employees more often perceived symptoms of shortness of breath (5.2% of respondents) and fever or chills (3.7%) than the other groups (Table 1). The office employees less often perceived, for example, symptoms of irritation of the nose (21.5% of respondents), irritation of the eyes (21.4%),

Table 1. Perceived indoor environment-related (IE-related) weekly complaints and symptoms in office, school and health care environments according to 28 826 *IA Questionnaire* responses from Finnish workplaces from 2011–2012 and 2015–2017

Complaint	Variable	Respondents (N = 28 826)											
		office employees (N = 16 545)				school employees (N = 5241)				health care employees (N = 7040)			
		n	M%	95% CI	n	n	M%	95% CI	n	M%	95% CI	n	M%
stuffy air		4831	30.0	29.3–30.7	2175	42.1	40.8–43.4	3862	55.7	54.5–56.9	38.5		
dry air		4445	27.7	27.0–28.4	1500	29.6	28.3–30.9	3424	49.9	48.7–51.1	33.5		
insufficient ventilation		3995	25.0	24.3–25.7	1933	37.9	36.6–39.2	3280	47.7	46.5–48.9	33.0		
noise		2407	15.1	14.5–15.7	1658	32.8	31.5–34.1	1472	21.7	20.7–22.7	20.0		
draft		2616	16.7	16.1–17.3	890	17.8	16.7–18.9	1881	28.3	27.2–29.4	19.7		
unpleasant odor		1945	12.2	11.7–12.7	1010	19.9	18.8–21.0	2072	30.5	29.4–31.6	18.1		
dust or dirt		2670	16.6	16.0–17.2	1029	20.2	19.1–21.3	1185	17.4	16.5–18.3	17.5		
too low room temperature		2435	15.4	14.8–16.0	848	16.9	15.9–17.9	1288	19.3	18.4–20.2	16.6		
varying room temperature		2067	13.1	12.6–13.6	627	12.6	11.7–13.5	1479	22.0	21.0–23.0	15.2		
mould odor		1346	8.5	8.1–8.9	789	15.6	14.6–16.6	1815	26.6	25.6–27.6	14.2		
dim light or reflections		1297	8.2	7.8–8.6	467	9.2	8.4–10.0	931	13.7	12.9–14.5	9.7		
too high room temperature		1146	7.3	6.9–7.7	337	6.8	6.1–7.5	939	14.1	13.3–14.9	8.9		
tobacco smoke		315	2.0	1.8–2.2	62	1.2	0.9–1.5	355	5.2	4.7–5.7	2.6		
Symptom													
irritation of the nose		3524	21.5	20.9–22.1	1413	27.2	26.0–28.4	2736	39.2	38.1–40.3	26.9		
irritation of the eyes		3484	21.4	20.8–22.0	1221	23.6	22.4–24.8	2633	37.8	36.7–38.9	25.8		
hoarse, dry throat		3138	19.2	18.6–19.8	1470	28.4	27.2–29.6	2358	33.8	32.7–34.9	24.4		
fatigue		2397	14.6	14.1–15.1	1113	21.4	20.3–22.5	1810	25.9	24.9–26.9	18.6		
feeling heavy-headed		1930	11.9	11.4–12.4	985	19.1	18.0–20.2	1799	26.0	25.0–27.0	16.6		
irritation of the skin on the hands		1737	10.7	10.2–11.2	804	15.6	14.6–16.6	1682	24.2	23.2–25.2	14.9		
irritation of the skin on the face		1684	10.4	9.9–10.9	737	14.3	13.3–15.3	1401	20.2	19.3–21.1	13.5		
headache		1488	9.2	8.8–9.6	785	15.2	14.2–16.2	1293	18.7	17.8–19.6	12.6		
coughing		1240	7.6	7.2–8.0	568	11.0	10.1–11.9	979	14.1	13.3–14.9	9.8		

concentration difficulties	1379	8.5	8.1–8.9	381	7.4	6.7–8.1	623	9.0	8.3–9.7	8.5
joint pain	638	3.9	3.6–4.2	243	4.7	4.1–5.3	460	6.6	6.0–7.2	4.7
muscular pain	687	4.3	4.0–4.6	180	3.5	3.0–4.0	438	6.4	5.8–7.0	4.6
shortness of breath	488	3.0	2.7–3.3	266	5.2	4.6–5.8	346	5.0	4.5–5.5	3.9
fever or chills	382	2.4	2.2–2.6	193	3.7	3.2–4.2	244	3.5	3.1–3.9	2.9
coughing at night	306	1.9	1.7–2.1	158	3.1	2.6–3.6	236	3.4	3.0–3.8	2.5
wheezing	248	1.5	1.3–1.7	120	2.3	1.9–2.7	172	2.5	2.1–2.9	1.9

Table 2. Perceived indoor environment-related (IE-related) weekly complaints and symptoms and the 25th–95th percentile distribution of responses in office, school and health care workplaces according to 28 826 *IA Questionnaire* responses from Finnish workplaces from 2011–2012 and 2015–2017

Variable	Respondents (N = 28 826)																				
	office employees (N = 16 545)							school employees (N = 5241)							health care employees (N = 7040)						
	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. [%]	max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. [%]	max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. [%]	max [%]
Complaint																					
draft	2616	9	16	24	40	0	61	890	8	16	22	41	0	89	1881	15	24	35	51	0	72
too high room temperature	1146	2	5	9	20	0	67	337	2	5	9	25	0	44	939	5	12	18	44	0	60
varying room temperature	2067	6	11	17	34	0	58	627	6	12	16	28	0	61	1479	13	18	27	49	0	69
too low room temperature	2435	8	14	20	37	0	63	848	8	13	23	43	0	89	1288	11	17	24	36	0	50
stuffy air	4831	15	28	43	65	0	95	2175	29	40	52	73	9	89	3862	36	49	64	83	0	100
dry air	4445	18	26	35	55	0	80	1500	17	28	38	62	0	100	3424	35	48	60	78	6	88
insufficient ventilation	3995	13	22	35	58	0	95	1933	25	37	49	67	0	84	3280	29	43	58	77	0	100
mould odor	1346	0	4	12	43	0	71	789	4	14	22	46	0	62	1815	10	18	31	59	0	78
unpleasant odor	1945	3	9	17	38	0	75	1010	8	17	28	42	0	72	2072	16	26	36	50	0	79
tobacco smoke	315	0	1	3	11	0	33	62	0	0	0	5	0	14	355	0	3	6	18	0	48
noise	2407	4	9	16	35	0	67	1658	19	33	50	63	0	84	1472	9	16	26	55	0	71
dim light or reflections	1297	4	7	10	20	0	30	467	5	9	13	24	0	35	931	6	10	17	36	0	57
dust or dirt	2670	6	13	22	47	0	88	1029	9	16	27	63	0	100	1185	6	14	27	40	0	67

Table 2. Perceived indoor environment-related (IE-related) weekly complaints and symptoms and the 25th–95th percentile distribution of responses in office, school and health care workplaces according to 28 826 *IA Questionnaire* responses from 2011–2012 and 2015–2017 – cont.

Variable	Respondents (N = 28 826)												health care employees (N = 7040)											
	office employees (N = 16 545)						school employees (N = 5241)																	
	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. max [%]
Symptom																								
fatigue	2397	7	12	19	37	2 73	1113	11	18	29	52	0 63	1810	14	21	31	45	0 68						
feeling heavy-headed	1930	4	8	18	33	0 67	985	8	16	24	46	3 76	1799	12	21	31	44	0 80						
headache	1488	3	7	12	31	0 53	785	6	13	20	35	0 47	1293	9	16	22	40	0 59						
concentration difficulties	1379	4	7	11	23	0 47	381	4	6	11	19	0 35	623	4	7	11	26	0 55						
irritation of the eyes	3484	12	19	29	49	3 72	1221	10	22	31	48	0 72	2633	26	34	44	59	0 79						
irritation of the nose	3524	11	19	30	50	0 73	1413	17	26	34	47	3 67	2736	24	35	44	63	8 80						
hoarse, dry throat	3138	9	15	29	49	0 73	1470	16	26	36	53	3 69	2358	20	28	39	57	4 69						
coughing	1240	3	6	11	24	0 38	568	5	9	15	25	0 39	979	6	11	17	33	0 38						
coughing at night	306	0	1	3	9	0 29	158	0	1	5	10	0 18	236	0	2	5	13	0 22						
irritation of the skin on the face	1684	4	9	15	30	0 56	737	6	11	18	33	0 61	1401	12	18	24	41	0 67						
irritation of the skin on the hands	1737	4	9	15	25	0 57	804	7	13	21	33	0 83	1682	12	23	30	46	0 65						
shortness of breath	488	0	2	5	13	0 53	266	0	4	7	17	0 25	346	1	3	7	13	0 30						
wheezing	248	0	0	2	8	0 29	120	0	1	4	8	0 13	172	0	1	4	8	0 17						
fever or chills	382	0	1	4	13	0 40	193	0	2	6	12	0 26	244	0	2	4	12	0 22						
joint pain	638	1	3	6	14	0 36	243	0	4	7	14	0 28	460	3	5	9	17	0 31						
muscular pain	687	1	4	6	15	0 33	180	0	2	5	12	0 15	438	2	6	8	17	0 35						

P – percentile.

Table 3. Perceived indoor environment-related (IE-related) weekly complaints and symptoms in office, school and health care workplaces which were monitoring the state of perceived IE, for example, after IA-related repairs according to 28 826 *IA Questionnaire* responses from Finnish workplaces from 2011–2012 and 2015–2017

Variable	Respondents (N = 4244)									
	office employees (N = 2891)			school employees (N = 587)			health care employees (N = 766)			total
	n	M%	95% CI	n	M%	95% CI	n	M%	95% CI	
Complaint										
stuffy air	760	27.1	25.5–28.7	232	39.7	35.7–43.7	454	59.7	56.2–63.2	34.8
dry air	855	30.5	28.8–32.2	182	31.8	28.0–35.6	384	51.3	47.7–54.9	34.5
insufficient ventilation	589	21.2	19.7–22.7	199	34.6	30.7–38.5	360	47.9	44.3–51.5	28.0
noise	398	14.4	13.1–15.7	203	35.4	31.5–39.3	161	21.6	18.6–24.6	18.6
draft	487	17.9	16.5–19.3	92	16.2	13.2–19.2	229	31.2	27.8–34.6	20.1
unpleasant odor	338	12.1	10.9–13.3	100	17.5	14.4–20.6	226	30.2	26.9–33.5	16.1
dust or dirt	383	13.7	12.4–15.0	76	13.2	10.4–16.0	152	20.5	17.6–23.4	14.9
too low room temperature	422	15.3	14.0–16.6	97	17.1	14.0–20.2	179	24.3	21.2–27.4	17.2
varying room temperature	392	14.3	13.0–15.6	66	11.7	9.0–14.4	175	23.9	20.8–27.0	15.6
mould odor	191	6.9	6.0–7.8	82	14.3	11.4–17.2	208	27.9	24.7–31.1	11.7
dim light or reflections	205	7.4	6.4–8.4	47	8.2	6.0–10.4	107	14.4	11.9–16.9	8.8
too high room temperature	263	9.6	8.5–10.7	24	4.3	2.6–6.0	96	13.3	10.8–15.8	9.5
tobacco smoke	37	1.3	0.9–1.7	7	1.2	0.3–2.1	39	5.2	3.6–6.8	2.0
Symptom										
irritation of the nose	660	23.1	21.6–24.6	187	32.0	28.2–35.8	325	42.7	39.2–46.2	27.9
irritation of the eyes	645	22.7	21.2–24.2	158	27.1	23.5–30.7	326	43.1	39.6–46.6	27.0
hoarse, dry throat	587	20.6	19.1–22.1	206	35.2	31.3–39.1	276	36.4	33.0–39.8	25.5
fatigue	367	12.9	11.7–14.1	144	24.7	21.2–28.2	229	30.2	26.9–33.5	17.6
feeling heavy-headed	304	10.8	9.7–11.9	119	20.6	17.3–23.9	247	32.6	29.3–35.9	16.1
irritation of the skin on the hands	323	11.4	10.2–12.6	91	15.7	12.7–18.7	213	28.2	25.0–31.4	15.0
irritation of the skin on the face	317	11.2	10.0–12.4	110	18.9	15.7–22.1	187	24.7	21.6–27.8	14.7
headache	211	7.5	6.5–8.5	110	18.8	15.6–22.0	173	22.8	19.8–25.8	11.9
coughing	223	7.9	6.9–8.9	71	12.2	9.5–14.9	132	17.5	14.8–20.2	10.2
concentration difficulties	247	8.8	7.8–9.8	50	8.7	6.4–11.0	86	11.5	9.2–13.8	9.3

Table 3. Perceived indoor environment-related (IE-related) weekly complaints and symptoms in office, school and health care workplaces which were monitoring the state of perceived IE, for example, after IA-related repairs according to 28 826 *IA Questionnaire* responses from Finnish workplaces from 2011–2012 and 2015–2017 – cont.

Variable	Respondents (N = 4244)									
	office employees (N = 2891)			school employees (N = 587)			health care employees (N = 766)			total
	n	M%	95% CI	n	M%	95% CI	n	M%	95% CI	M%
Symptom – cont.										
joint pain	116	4.1	3.4–4.8	30	5.1	3.3–6.9	74	9.8	7.7–11.9	5.3
muscular pain	102	3.6	2.9–4.3	23	3.9	2.3–5.5	64	8.5	6.5–10.5	4.6
shortness of breath	85	3.0	2.4–3.6	38	6.5	4.5–8.5	47	6.2	4.5–7.9	4.1
fever or chills	61	2.2	1.7–2.7	29	5.0	3.2–6.8	32	4.2	2.8–5.6	2.9
coughing at night	52	1.9	1.4–2.4	13	2.3	1.1–3.5	30	4.0	2.6–5.4	2.3
wheezing	51	1.8	1.3–2.3	16	2.7	1.4–4.0	25	3.3	2.0–4.6	2.2

hoarse or dry throat (19.2%), fatigue (14.6%), or feeling heavy-headed (11.9%) than the health care and school employees (Table 1).

Table 2 shows the data on the distribution of perceived IE-related weekly symptoms. The mean values in Table 1 are within the range of 50th–75th percentile (Table 2).

Table 3 illustrates the percent mean values of employees' IE-related symptoms in workplaces that were monitoring the state of perceived IE, for example, after IA-related repairs. In addition, IE-related symptoms were common in these workplaces.

Perceived psychosocial work environment and stress

The school employees and health care employees perceived their work as more interesting and stimulating than the office employees (Table 4). The office employees (17.2% of respondents) felt they often had too much work to do and reported this more often than the school (13.9%) or the health care employees (16.6%) (Table 4). The school employees (34.6% of respondents) were able to influence their working conditions more often than the health care employees (27.5%) (Table 4). The health care employees (77.7% of respondents) felt that they received help from their fellow employees in their work more often than the office (72.7%) and school (73.3%) employees (Table 4). The office employees (3.6% of respondents) most often experienced “very much” stress in their work. The health care workers (17.7% of respondents) most often reported “not at all” being stressed in their work (Table 4).

Table 5 shows the data on the distribution of perceived psychosocial work environment and stress. The mean values in Table 4 mostly fall within the range of 50th–75th percentile (Table 5).

DISCUSSION

The data used in the study were extensive and described the perceived IA situation in office, school and health

care environments in Finland very well. The standardized *IA Questionnaire* and its use are well established, which increases the reliability of the study. The present study enabled the authors to compare the differences between employees' IE-related symptoms, environmental complaints and psychosocial work environments in office, school and health care environments. The previous Finnish study, and the reference values for non-industrial workplaces and hospital environments, which were created through *IA Questionnaires*, were from 2004 and 2008 [1,15,21]. This study adds to the information provided by the previous study. The results of this study show that perceived IE-related symptoms and environmental complaints in health care environments have changed since the earlier FIOH study results in 2008 [1]. In addition, the authors found differences between the prevalence of IE-related complaints and symptoms among the employees in office, school and health care environments.

In the offices, the environmental complaints made most often referred to stuffy air, dry air, insufficient ventilation, draft and unpleasant odors. The most common symptoms were irritated/runny nose, irritation of the eyes, hoarse throat, fatigue and feeling heavy-headed. These most frequently perceived symptoms and environmental complaints have also been commonly found in other studies [12,13,21].

In health care environments, the perceived environmental complaints had increased noticeably since FIOH's earlier study results and reference values in 2008 [1]. The environmental complaints most often addressed were stuffy air, dry air, insufficient ventilation, unpleasant odors and mould odor. These environmental complaints were also the most common complaints in FIOH's earlier study [1]. Environmental complaints about stuffy air, unpleasant odors, dry air and dust or dirt also found to be common in other studies [29]. Notably, noise was no longer experienced so much in hospital environments, but complaints of mould odor were higher in number than before.

The most often perceived symptoms were irritated/runny nose, irritation of the eyes, hoarse throat, fatigue and feeling heavy-headed. These perceived symptoms also found to be common in FIOH's earlier study [1] and other studies [2]. The prevalence of the symptoms and environmental complaints had both increased.

School employees' environmental complaints most often addressed stuffy air, insufficient ventilation, noise, dry air, and dust or dirt. Notably, noise was complained about much more often in schools than in office or health care environments. The most often perceived symptoms were hoarse throat, irritated/runny nose, fatigue, feeling heavy-headed, and irritation of the skin on the hands. Other studies [23,26,30] have also found these perceived environmental complaints [23] and symptoms [26,30] to be common.

The employees in health care environments more often regarded their work as interesting and stimulating; they had fewer situations with too much work, and more possibilities to influence their working conditions than in FIOH's 2008 study [1]. In some respects, similar trends can be found in Statistics Finland's Quality of Work Life Survey 2013 [7]. This nationwide survey showed that wage and salary earners' general satisfaction with their current jobs, and especially with the content of their tasks, social relations and the ability to influence the workplace, had increased since 2008, whereas experiences of time pressure had eased during the studied period.

One interesting aspect in the authors' results was that although the office employees found their work less interesting, more often had too much work and experienced slightly more stress than the other study groups, they nevertheless reported less environmental discomfort and fewer symptoms than the school and health care employees. This seems to contradict the results of earlier studies, which have reported significant associations between the psychosocial environment and both IE-related complaints and symptoms [15,17]. Further studies should pay attention to this issue.

Table 4. Perceived psychosocial work environment and stress in office, school and health care work according to 28 826 I4 Questionnaire responses from Finnish workplaces from 2011–2012 and 2015–2017

Response option	Respondents (N = 28 826)									
	office employees (N = 16 545)			school employees (N = 5241)			health care employees (N = 7040)			total
	n	M%	95% CI	n	M%	95% CI	n	M%	95% CI	
“Do you regard your work as interesting and stimulating?”										
“yes, often”	12 201	74.2	73.5–74.9	4433	85.0	84.0–86.0	5888	84.0	83.1–84.9	78.5
“yes, sometimes”	3583	21.8	21.2–22.4	703	13.5	12.5–14.4	964	13.7	12.9–14.5	18.3
“no, seldom or rarely”	608	3.7	3.4–4.0	76	1.5	1.2–1.8	140	2.0	1.7–2.3	2.9
“never”	57	0.3	0.2–0.4	5	0.1	0.01–0.2	19	0.3	0.2–0.4	0.3
“Do you have too much work?”										
“yes, often”	2822	17.2	16.6–17.8	725	13.9	13.0–14.8	1162	16.6	15.7–17.5	16.5
“yes, sometimes”	9114	55.6	54.8–56.4	3010	57.8	56.5–59.1	4124	58.9	57.7–60.1	56.8
“no, seldom or rarely”	4029	24.6	23.9–25.3	1317	25.3	24.1–26.5	1568	22.4	21.4–23.4	24.2
“never”	439	2.7	2.5–2.9	153	2.9	2.4–3.4	149	2.1	1.8–2.4	2.6
“Are you able to influence your working conditions?”										
“yes, often”	5470	33.5	32.8–34.2	1797	34.6	33.3–35.9	1919	27.5	26.5–28.5	32.2
“yes, sometimes”	7277	44.5	43.7–45.3	2576	49.6	48.2–51.0	3265	46.8	45.6–48.0	46.0
“no, seldom or rarely”	3087	18.9	18.3–19.5	746	14.4	13.4–15.4	1597	22.9	21.9–23.9	19.0
“never”	512	3.1	2.8–3.4	77	1.5	1.2–1.8	193	2.8	2.4–3.2	2.7
“Do your fellow workers help you with work-related problems?”										
“yes, often”	11 945	72.7	72.0–73.4	3824	73.3	72.1–74.5	5445	77.7	76.7–78.7	74.0
“yes, sometimes”	3782	23.0	22.4–23.6	1178	22.6	21.5–23.7	1338	19.1	18.2–20.0	22.0
“no, seldom or rarely”	628	3.8	3.5–4.1	186	3.6	3.1–4.1	197	2.8	2.4–3.2	3.5
“never”	77	0.5	0.4–0.6	27	0.5	0.3–0.7	27	0.4	0.3–0.5	0.5
“Do you experience stress?”										
“not at all”	2247	13.8	13.3–14.3	704	13.7	12.8–14.6	1221	17.7	16.8–18.6	14.7
“just a little”	6055	37.2	36.5–37.9	1878	36.6	35.3–37.9	2457	35.6	34.5–36.7	36.7
“some”	5222	32.1	31.4–32.8	1712	33.3	32.0–34.6	2195	31.8	30.7–32.9	32.2

“quite a lot”	2163	13.3	12.8–13.8	687	13.4	12.5–14.3	816	11.8	11.0–12.6	12.9
“very much”	588	3.6	3.3–3.9	156	3.0	2.5–3.5	222	3.2	2.8–3.6	3.4

Table 5. Perceived psychosocial work environment, stress and the 25th–95th percentile distribution of responses in office, school and health care workplaces according to 28 826 *IA Questionnaire* responses from Finnish workplaces from 2011–2012 and 2015–2017

Response option	Participants (N = 28 826)																				
	office employees (N = 16 545)							school employees (N = 5241)							health care employees (N = 7040)						
	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. [%]	max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. [%]	max [%]	n	P ₂₅	P ₅₀	P ₇₅	P ₉₅	min. [%]	max [%]
“Do you regard your work as interesting and stimulating?”	12 201	66	74	81	90	35	97	4433	79	85	90	96	61	100	5888	77	84	89	95	37	100
“yes, often”	665	2	4	6	13	0	33	81	0	0	3	6	0	12	159	0	1	4	8	0	27
“no, seldom or rarely”																					
“Do you have too much work?”	2778	10	16	22	33	0	44	725	7	12	20	30	0	36	1162	9	15	23	35	0	68
“yes, often”	4468	18	24	33	55	0	93	1470	21	27	34	48	3	85	1717	16	23	33	55	0	82
“no, seldom or rarely”																					
“Are you able to influence your working conditions?”	5470	24	33	40	53	0	64	1797	27	32	42	51	14	67	1919	19	27	39	58	4	81
“yes, often”	3599	15	21	29	47	0	72	823	12	16	22	32	0	52	1790	15	25	34	44	0	52
“no, seldom or rarely”																					
“Do your fellow workers help you with work-related problems?”	11 945	66	73	80	91	39	100	3824	64	74	81	88	27	96	5445	71	77	84	95	50	100
“yes, often”	705	1	4	6	13	0	24	213	0	3	6	10	0	47	224	0	3	5	9	0	20
“no, seldom or rarely”																					
“Do you experience stress?”	2751	12	16	23	33	0	43	843	10	15	21	34	0	47	1038	10	14	18	29	0	48
“quite a lot or very much”	11 277	64	69	74	83	41	93	3590	64	71	76	83	41	85	4652	61	68	75	83	48	100
“some or just a little”	2247	9	13	18	27	0	53	704	8	12	17	31	0	35	1221	12	16	23	33	0	50
“not at all”																					

P – percentile.

In this study, the authors present both the distribution and mean values of the questionnaire results. The examination of the distribution values was justified because 59% of the responses were from workplaces with suspected IE-related problems. The authors formulated a hypothesis that complaints and symptoms would be more common in the overall data, in which 59% of the workplaces had suspected IE-related problems, than in the data from the subgroup of workplaces that were monitoring perceived IE. However, contrary to the authors' hypothesis, IE-related complaints and symptoms were also common in the subgroup.

Buildings and spaces, the factors affecting IA, people's subjective and individual differences, and their experience of the psychosocial work environment vary [8], making it difficult to define unambiguous reference values for interpreting *IA Questionnaire*. Instead of exact reference values, comparing the results of *Örebro MM-40*-based questionnaire with the distributions and mean values of the results of this study may be more informative for those solving IE-related problems. The reported IE-related complaints and symptoms with values of <25th–75th percentile may represent workplaces that are unlikely to require further surveys (e.g., building investigations, occupational health service surveys). The reported IE-related complaints and symptoms with values of 75th percentile → 95th percentile, in turn, may represent workplaces that need further inspections.

The presented distribution and mean values also enable the analysis of the psychosocial work environment at the workplace and the evaluation of possible effects on symptoms and complaints. Furthermore, the presented distribution and mean values might relate the results to other workplaces when interpreting *Örebro MM-40*-based questionnaire results and solving IE-related problems. This might increase the understanding that questionnaire results are influenced by many factors and that each workplace, situation and human experience is different.

The measures required at each workplace should always be evaluated from many perspectives and the results of *IA Questionnaires* are only a part of IE problem-solving.

The present study shows that perceived IE varies according to work environments and that IE experiences have changed since earlier study results. Therefore, it is also recommendable to use the present results as new reference data to interpret *Örebro MM-40*-based questionnaire results in offices, schools and health care workplaces in Finland.

The authors' study has some limitations. The data contained only self-reported *IA Questionnaires* results and the authors had no information on, for example, the workplace buildings and their condition or the current situation of the work organizations. The information on possible IE-related problems was based on the workplace's own assessment. Moreover, there was no information on the reasons why the workplaces that were monitoring the state of perceived IE were doing so. In addition, the questions concerning the psychosocial work environment in the *Örebro MM-40*-based questionnaire were quite limited. The questionnaire did not include, for instance, factors such as organizational changes and questions concerning leadership. It was not possible to assess different causal relationships in this study. It was also impossible, due to limitations of the data, to establish why the perceived IE-related symptoms and environmental complaints differed between the office, school and health care environments. The school category included different types of school environments, such as elementary schools and universities. In addition, 59% of the responses were from workplaces with suspected IE-related problems. The perceived environmental complaints and symptoms were probably slightly higher than in a random sample.

Future studies should assess the relationship between symptoms and perceived environmental complaints, as well as between the IAQ and symptoms and environmental complaints. Further studies of the psychosocial environment are needed which address both IE-related complaints and symptoms. Studies should also assess whether

individual factors can explain the symptoms, environmental complaints, and perceived psychosocial work environment. It would also be interesting to determine whether the workplace is private or public, which may partly be associated with some IE-related complaints.

CONCLUSIONS

There are differences between perceived IE in office, school and health care environments. Most of the perceived IE-related symptoms and environmental complaints had increased in health care environments since the earlier study results of the 2000s. The office employees' perceptions of psychosocial work environment remained fairly unchanged whereas the health care personnel more often assessed their psychosocial environment as positive compared to earlier findings.

Instead of exact reference values, comparing the results of *IA Questionnaires* with the distributions and mean values of the results of this study may be more informative for those striving to solve IE-related problems. The presented distribution and mean values of perceived symptoms, environmental complaints and psychosocial work environment might help to relate the results to other workplaces when interpreting *IA Questionnaire* results and solving IE-related problems. The reported IE-related complaints and symptoms with values within the range of <25th–75th percentile may represent workplaces that are unlikely to require further surveys (e.g., building investigations, occupational health service surveys), and the reported IE-related complaints and symptoms with values of 75th percentile → 95th percentile may represent workplaces that need further investigations.

The presented distribution and mean values of perceived symptoms, environmental complaints and psychosocial work environment might help to relate results to other workplaces when interpreting *Örebro MM-40*-based questionnaire results and solving IE-related problems. This, in turn, might increase the understanding that *IA Questionnaire*

results are influenced by many factors and that each workplace, situation and human experience is different. Notably, *IA Questionnaires* are only a part of IE problem-solving.

The results presented can be used as new reference material when interpreting *Örebro MM-40*-based questionnaire results in office, school and health care environments.

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